Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES

P-ISSN 2581-1657
E-ISSN 2581-2203

The Effect of Arithmetic Operations Pockets Media on Improving Concept Understanding and Critical Thinking Skills of Grade 3 Students of SD Negeri 10 Silih Nara

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ARTICLE INFO

Article history:

Received: 30 Dec 2025
Revised: 03 March 2026
Accepted: 25 March 2026
Published online: 05 April 2026

Keywords:

Arithmetic Operation Bag Media,
Conceptual Understanding,
Critical Thinking Skills,
Mathematics Learning,
Elementary School Students

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Article Doi:

https://doi.org/10.31258/jes.10.4.p.1-12

A B S T R A C T

This study examines the effect of multiplication pocket media on conceptual understanding and critical thinking skills of third-grade students in elementary school mathematics learning. Mathematics learning at the elementary school level often faces challenges due to the abstract nature of mathematical concepts, particularly multiplication, which is less compatible with students' cognitive development at the concrete operational stage. This study employed a quantitative approach using a one-group pretest–posttest pre-experimental design involving 30 third-grade students at SD Negeri 10 Silih Nara. Data were collected through validated and reliable essay-based tests designed to measure conceptual understanding and critical thinking skills. The results showed a significant improvement in students' learning outcomes, with the mean score increasing from 63.00 in the pretest to 87.33 in the posttest. The Wilcoxon Signed-Rank Test indicated a significant difference between pretest and posttest scores (Sig. = 0.000 < 0.05). Furthermore, the N-Gain score of 0.738 was categorized as high, indicating that the multiplication pocket media effectively improves students' learning outcomes. These findings suggest that the use of concrete and manipulative learning media can enhance students' conceptual understanding and critical thinking skills in elementary mathematics learning.

1. Introduction

Education is a consciously and systematically designed process designed to create a learning environment that enables students to develop optimally, across cognitive, affective, and psychomotor domains. Education serves not merely as a means of transferring knowledge, but as a strategic vehicle for developing individuals with critical thinking, independence, and character. Arikunto (2013) asserts that education is essentially a process of humanizing individuals, namely developing

individuals who are intelligent, reflective, and morally sound in facing the dynamics of life. This view positions education as the primary foundation for developing quality and sustainable human resources.

In line with this thinking, Dewey views education as the process of developing an individual's basic intellectual and emotional abilities, enabling them to interact adaptively with their social and natural environment (Rosiana et al., 2023; Achjar, 2008). Hamalik adds that education is a conscious effort to influence students to adapt optimally to their environment, resulting in meaningful behavioral change (Oktama et al., 2026; Wulandari et al., 2024). Thus, education can be understood as a planned process carried out by educators to guide students in developing their physical and mental potential in a balanced manner.

In the context of formal education, educational objectives play a central role as both a direction and a benchmark for learning success. The Indonesian National Education Goals emphasize the development of individuals who are faithful, knowledgeable, capable, creative, independent, and responsible. To achieve these goals, the learning process must be adapted to the developmental characteristics of students. According to Piaget, elementary school-aged children are in the concrete operational stage, a phase of cognitive development characterized by logical thinking abilities that are still heavily dependent on real-life experiences and concrete objects (Muti'ah et al., 2024; Anderha et al., 2021; Wahyuni & Darmawan, 2023). Therefore, learning presented abstractly without the support of concrete media has the potential to cause difficulties in understanding, particularly in mathematics.

Mathematics, as a core subject, plays a strategic role in developing logical, systematic, and analytical thinking skills. Indriana (2011) states that mathematics is a science structured logically and deductively, focusing on patterns of relationships and organized structures. Makbul (2021) emphasized that mathematics serves not only as a tool for understanding natural phenomena but also as a means to train rational thinking skills and data-driven decision-making. Therefore, mastery of mathematics from elementary school onward is a crucial foundation for students' learning success at subsequent levels. However, mathematics learning in elementary schools still faces various challenges, particularly in conceptual understanding. Ahmad (2013) emphasizes that the abstract and deductive nature of mathematics requires an appropriate learning approach to ensure its comprehension by students still at the concrete operational stage. This mismatch between the learning approach and students' cognitive developmental stage often leads to poor conceptual understanding, particularly in arithmetic operations such as multiplication.

Conceptual understanding is a cognitive ability that reflects the extent to which students are able to interpret, relate, and apply a concept meaningfully. Makbul (2021) states that understanding is at a higher cognitive level than factual knowledge because it involves mental processes such as interpreting and constructing meaning. Muttaqin & Rizkiyah (2022) emphasize that mathematical conceptual understanding has indicators that include the ability to re-explain

concepts, classify objects, apply procedures, present examples and non-examples, and represent concepts in various forms. Without a strong conceptual understanding, students tend to simply memorize procedures without understanding the mathematical meaning behind them. In addition to conceptual understanding, critical thinking skills are also an important competency that needs to be developed through mathematics learning. Yaumi (2012) defines critical thinking as a reflective and rational thought process to determine what to believe or do. Silvia et al. (2022) states that critical thinking is a mental attitude that involves the ability to analyze, evaluate, and make logical decisions. In an educational context, critical thinking skills play a crucial role in helping students solve problems, evaluate information, and construct argumentative reasoning.

Various studies show that poor understanding of mathematical concepts often correlates with low critical thinking skills in students (Samidi & Istarani, 2016; Rizqi et al., 2025; Elfiza et al., 2025). Learning methods that are still dominated by conventional lectures and practice problems tend to make students passive and focused only on the end result, rather than the thinking process. This condition is exacerbated by the limited use of concrete learning media that can bridge abstract concepts with students' real-life experiences. Learning media plays a crucial role in enhancing learning effectiveness. Muliastrini (2020) stated that learning success is influenced by various factors, including the methods and media used. Indriana (2011) emphasized that learning media can stimulate direct learning experiences, increase motivation, and strengthen students' memory. Wahyudin & Agustin (2012) suggested that media serve to convey information, motivate learning, and facilitate meaningful learning activities.

In elementary school mathematics learning, concrete media are essential to help students understand the concept of multiplication as repeated addition. One media relevant to the characteristics of concrete operational students is the Arithmetic Operations Bag Media. This media is manipulative and allows students to visualize the concept of multiplication through grouping real objects. The use of this type of concrete media aligns with Egok (2016) and Depdiknas (2003) view, which emphasizes that meaningful learning occurs when students can connect new knowledge to their direct experiences.

In addition to aiding conceptual understanding, concrete media also has the potential to stimulate students' critical thinking skills. Through activities such as observing, classifying, comparing, and drawing conclusions, students are trained to think reflectively and logically. Desmita (2016) emphasizes that developing critical thinking requires learning experiences that challenge students to analyze information, evaluate assumptions, and consider alternative solutions. Based on this explanation, it can be concluded that students' low conceptual understanding and critical thinking skills in mathematics, particularly in multiplication, are issues that require serious attention. Learning innovations are needed that align with students' cognitive developmental stages and facilitate active, concrete, and meaningful learning. Therefore, this study aims to analyze the effect of using Arithmetic Operation Pockets on conceptual understanding and critical thinking skills of third-grade students at SD Negeri 10 Silih Nara. This research is expected to provide

theoretical contributions to the development of elementary school mathematics learning and practical contributions to teachers in selecting and implementing effective learning media.

2. Methodology

This study used a quantitative approach with a pre-experimental approach. Pre-experimental research is preliminary research aimed at determining changes after treatment, but cannot yet draw strong conclusions about cause-and-effect relationships due to limited control over external variables (Sugiyono, 2018). The quantitative approach was chosen because this study focused on testing the effect of using arithmetic operation pockets on conceptual understanding and critical thinking skills of third-grade elementary school students. Student learning outcomes data were collected through cognitive tests in the form of pretests and posttests.

The research design used was a One-Group Pretest–Posttest Design, a form of pre-experimental design. In this design, research subjects were given a pretest before treatment and a posttest after treatment, allowing changes in learning outcomes to be analyzed by comparing conditions before and after treatment (Sugiyono, 2018; Hasanah et al., 2024). The treatment consisted of mathematics learning using arithmetic operation pockets on multiplication. The population in this study was all students of SD Negeri 10 Silih Nara, Central Aceh Regency. The research sample was determined using a simple random sampling technique, which involves random sampling without considering strata within the population (Sugiyono, 2018; Rizqi et al., 2025). The sample consisted of all 30 third-grade students at SD Negeri 10 Silih Nara in the 2025/2026 academic year.

This research was conducted at SD Negeri 10 Silih Nara, Silih Nara District, Central Aceh Regency, Aceh Province. The research took place from April to December 2025, encompassing the planning stage, instrument development, teaching implementation, data collection, and report preparation. The data collection techniques used in this study were tests and documentation. The tests were used to measure students' conceptual understanding and critical thinking skills through pretests and posttests. The tests were in the form of essay questions structured based on indicators of conceptual understanding and critical thinking in multiplication. Documentation was used as supporting data, including student data, school conditions, and learning activities during the study.

The research instrument, a descriptive test, measured two variables: conceptual understanding and critical thinking skills. Conceptual understanding includes the ability to restate concepts, provide examples and non-examples, summarize, and explain relationships between concepts. Critical thinking skills include the ability to identify problems, analyze arguments, and clarify answers. Assessment is conducted using a four-level scoring rubric. Instrument validity testing was conducted to determine the accuracy of the test items in measuring the research variables. Validity testing was conducted using the IBM SPSS program by

comparing the calculated r and table r values at a significance level of 0.05. The instrument is declared valid if the calculated r > table r (Samidi & Istarani, 2016; Maisaroh et al., 2025).

Reliability testing aims to determine the consistency of the research instrument. Reliability testing is conducted using the Cronbach's Alpha coefficient. The instrument is declared reliable if the reliability coefficient value is greater than 0.60 at a significance level of 0.05. Difficulty testing was conducted to determine the difficulty level of the test items, with a difficulty index ranging from 0.00 to 1.00. Discriminatory power testing was used to determine the item's ability to differentiate between high-ability and low-ability students. The criteria for assessing the level of difficulty and discriminating power refer to Sugiyono (2018).

Data analysis techniques were conducted after all data had been collected. The purpose of the analysis was to test the research hypothesis regarding the effect of arithmetic operation pocket media on students' conceptual understanding and critical thinking skills. Prior to hypothesis testing, the data were analyzed using normality and homogeneity tests as prerequisites for statistical analysis. Because the data did not meet the assumption of normal distribution, hypothesis testing was conducted using the Wilcoxon Signed-Rank Test to determine the difference in students' learning outcomes before and after the treatment. The hypothesis testing criterion was that if the Sig. (2-tailed) value was less than 0.05, the alternative hypothesis was accepted.

3. Results and Discussion

Result

This study employed a Pre-Experimental Design using a One-Group Pretest–Posttest Design. The analysis focused on changes in students' scores before and after treatment within the same group. The treatment consisted of learning using multiplication operation bag media. The data analyzed were the pretest and posttest scores of 30 third-grade students. The descriptive statistics are presented in Table 1.

Table 1. Descriptive Statistics

N		Minimum	Maximum	Mean	Std. Deviation
Pretest	30	40.00	80.00	63.0000	10.87547
Posttest	30	70.00	100.00	87.3333	8.68345
Valid N (listwise)	30				

Source: Processed data, (2025)

Table 1 shows an increase in the mean score from 63.00 (pretest) to 87.33 (posttest). The minimum score increased from 40 to 70, and the maximum score increased from 80 to 100. This indicates an improvement in students' conceptual understanding and critical thinking after the treatment. Instrument validation was conducted to ensure that the essay questions measured conceptual understanding

and critical thinking appropriately. The results of the validity test are presented in Table 2 and 3:

Table 2. Pre-test Validity Test Results

Question No.	r count	r table	Description
1	0.696	0.355	Valid
2	0.793	0.355	Valid
3	0.499	0.355	Valid
4	0.751	0.355	Valid
5	0.368	0.355	Valid
6	0.368	0.355	Valid
7	0.628	0.355	Valid
8	0.852	0.355	Valid
9	0.632	0.355	Valid
10	0.696	0.355	Valid

Source: Processed data, (2025)

Table 3. Post-test Validity Test Results

Question No.	r count	r table	Description
1	0.663	0.355	Valid
2	0.858	0.355	Valid
3	0.563	0.355	Valid
4	0.805	0.355	Valid
5	0.400	0.355	Valid
6	0.400	0.355	Valid
7	0.400	0.355	Valid
8	0.672	0.355	Valid
9	0.858	0.355	Valid
10	0.746	0.355	Valid

Source: Processed data, (2025)

Tables 2 and 3 show that the validity test results (r count > r table) indicate that all instrument items are valid, meaning each item is suitable for measuring the variables studied. Therefore, the data obtained is reliable and reflects the actual conditions of the respondents. After conducting a validity test on the test instrument, a reliability test was then conducted to determine whether the test items were reliable in measuring student learning outcomes. The following are the results of the reliability test for third-grade students at SDN 10 Silih Nara in Table 4.

Table 4. Reliability Test Results

Item	R Count	R table	Description
Pretest	0.777	0.355	Reliable
Posttest	0.786	0.355	Reliable

Source: Processed data, (2025)

Based on the reliability test results in Table 4, the significance test was conducted at the 0.05 level. Since $rhitung > rtabel$, it can be concluded that the instrument is reliable. This means that the instrument or questions used have a high level of consistency, so they can provide stable and reliable results when used repeatedly under the same conditions. Based on the results of the analysis of mathematics subject questions for class III SDN 10 Silih Nara using the operation bag media, it can be seen that the results obtained are as in tables 5 and 6:

Table 5. Pre-test Difficulty Test Results

No. Question	Level of Difficulty	Description
1	0.366	Medium
2	0.733	Easy
3	0.900	Easy
4	0.333	Medium
5	0.966	Easy
6	0.966	Easy
7	1.00	Easy
8	0.800	Easy
9	0.533	Medium
10	0.466	Medium

Source: Processed data, (2025)

Table 6. Post-test Difficulty Test Results

No. Question	Level of Difficulty	Description
1	0.366	Medium
2	0.766	Easy
3	0.900	Easy
4	0.433	Medium
5	0.966	Easy
6	0.966	Easy
7	0.966	Easy
8	0.833	Easy
9	0.766	Easy
10	0.600	Medium

Source: Processed data, (2025)

To determine the discriminatory power of the test items, an instrument test was conducted. This discriminatory power test attempted to identify the items' ability to differentiate between students who answered correctly and those who failed. Tables 7 and 8 below show the results of the test for discriminatory power of the test items in this study.

Table 7. Results of the Pre-test Differential Power Test

Question No.	Differential Power	Description
1	0.724	Very Good
2	0.758	Very Good
3	0.315	Average
4	0.596	Good
5	0.325	Average
6	0.325	Average
7	0.606	Good
8	0.786	Very Good
9	0.526	Good
10	0.724	Very Good

Source: Processed data, (2025)

Table 8. Results of the Post-test Differential Power Test

Question No.	Differential Power	Description
1	0.623	Good
2	0.822	Very Good
3	0.371	Average
4	0.695	Good
5	0.425	Good
6	0.425	Good
7	0.425	Good
8	0.658	Good
9	0.822	Very Good
10	0.642	Good

Source: Processed data, (2025)

Tables 7 and 8 above show that the difference test scores for both the pretest and posttest are in the moderate to excellent category. This indicates a significant improvement in learning outcomes after the treatment or learning process. This demonstrates that the learning implemented positively impacts student performance, as evidenced by the shift in scores from moderate in the pretest to good to excellent in the posttest. To analyze the differences between pretest and posttest scores, the Wilcoxon Signed-Rank Test was applied. The results are presented in Table 9:

Table 9. Wilcoxon Signed-Rank Test

Test Statistics[a]

	VAR00002 - VAR00001
Z	-4.849[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Source: Processed data, (2025)

Based on the Wilcoxon test result (Z = -4.849; N = 30), the effect size value indicates a strong effect. This shows that the multiplication pocket media has a substantial impact on students' learning improvement. Testing the effectiveness of the multiplication pocket media in mathematics learning was conducted using the N-Gain test. The N-Gain test was used to determine the extent of improvement in students' learning outcomes after receiving the treatment. The N-Gain calculation was carried out by comparing pretest and posttest scores. The following are the results of the N-Gain test on grade 3 students of SDN 10 Silih Nara in Table 10.

Table 10. N-Gain

N		Minimum	Maximum	Mean	Std. Deviation
NGain Score	30	.25	1.00	.7383	.24339
NGain Persen	30	25.00	100.00	73.8333	24.33857
Valid N (listwise)	30				

Source: Processed data, (2025)

Table 10 shows that the average N-Gain score is 0.738, which falls into the high effectiveness category. The N-Gain percentage of 73.83% indicates that the multiplication pocket media effectively improves students' learning outcomes after the treatment.

Discussion

This study employed a One-Group Pretest–Posttest Design to examine changes in students' learning outcomes after the implementation of multiplication pocket media in third-grade mathematics learning at SDN 10 Silih Nara. The analysis focused on differences in students' scores before and after the treatment within the same group. The results of the Wilcoxon Signed-Rank Test indicated a significance value of less than 0.05, demonstrating a statistically significant difference between pretest and posttest scores. This finding confirms that students' conceptual understanding and critical thinking skills improved following the use of the multiplication pocket media.

Furthermore, the N-Gain analysis demonstrated improvement within the high effectiveness category. This level of gain suggests that the learning media was pedagogically meaningful in facilitating students' conceptual development. In mathematics education, a high N-Gain indicates that instructional intervention supports conceptual restructuring rather than mere procedural memorization. The effectiveness of the multiplication pocket media can be interpreted through Piaget's theory of cognitive development, particularly the concrete operational stage. Third-grade students are developmentally characterized by their need for tangible and manipulable objects to construct understanding. The use of concrete media provides visual and physical representations of multiplication processes, enabling students to bridge abstract mathematical symbols with meaningful experiences. This explains why improvements were observed not only in conceptual understanding but also in critical thinking skills.

Additionally, the media promotes active engagement, encourages exploration of number relationships, and supports meaningful learning experiences. When students directly manipulate instructional materials, the learning process becomes more experiential and cognitively stimulating, which enhances deeper understanding. However, as a pre-experimental design, this study has limitations. The absence of a control group means that improvements cannot be attributed solely to the treatment without considering potential external factors such as maturation or testing effects. Therefore, causal interpretations should be made cautiously. Future studies employing quasi-experimental or true experimental designs with control groups are recommended to strengthen internal validity. Overall, the findings demonstrate not only statistical significance but also pedagogical relevance. The observed improvement indicates that multiplication pocket media is an effective instructional tool for supporting conceptual understanding and critical thinking development in elementary mathematics learning.

4. Conclusion

Based on the results of the research and data analysis, it can be concluded that there is a significant difference in students' conceptual understanding and critical thinking skills before and after the use of multiplication pocket media. Students showed meaningful improvement after the implementation of the media in mathematics learning. The findings indicate that the use of multiplication pocket media effectively enhances students' understanding of mathematical concepts as well as their critical thinking skills. Therefore, the application of concrete and interactive learning media can support more meaningful mathematics learning at the elementary school level.

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How to cite this article:

Suwarni., Yeni, E. M., & Afkar. (2026). A Needs Analysis-Based ESP Model for Islamic Education Management: Integrating Linguistic Expertise and Professional Practice. *Journal of Educational Sciences*, *10(4)*, 1-12.